

**US Army Corps
of Engineers®**

Engineer Research and
Development Center

Aquatic Plant Control Research Program

Vol A-02-1

August 2002

“So how much is it worth?” Economic Impacts of Recreational Fishing Under Different Aquatic Plant Conditions

by Jim E. Henderson and Phil Kirk

Introduction

The above question is usually asked to elicit a value (usually a monetary value) that allows natural resource managers to make a decision (“Go/No Go”), to perform an evaluation (“the benefit/cost ratio”), or to measure the effectiveness of some action. Management of aquatic plants is often perceived by the public as part of natural resources stewardship—a given, a responsibility or requirement—so that the “how much is it worth” question may not be asked. Extreme or controversial circumstances—high infestations, debate over levels of plants or management strategies—often cause economic benefits and costs to become of high interest. Unfortunately, the cost and time of obtaining economic information, usually through surveys, often discourage the use of economic analyses in developing plant management strategies.

This article reports on an evaluation of economic impacts

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

of nonnative plant conditions related to angling, undertaken by adapting existing survey efforts and utilizing recreation economic impact models. This provides fisheries and aquatic plant managers with the value of the economic output, income, and jobs associated with the existing plant conditions and with increasing plant conditions. By using the input-output (I-O) economic impact models, expenditure information collected by the creel surveys can be used to determine which industries and businesses benefit or are harmed by increasing aquatic plant infestations.

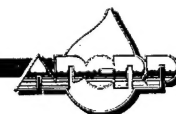
Background

Concepts of worth and value connote human use, and well-defined and quantified constructs have resulted in recognizable economic markets for many goods and services. Native and non-native aquatic plants are valued for the services provided by fisheries production, recreation,

water quality, and aquatic ecological functions. Use of natural resources by the public is valued, but the markets and values may be more difficult to define and the relationship of natural resources to public values may be unclear, disputed, or unquantifiable. Additionally, perceptions and the importance of contributions of aquatic plants to lake management may differ between anglers, waterskiers, property owners, and non-users of the resource.

Recreation as a good and service is of high interest to the public and is directly affected by users' response to the natural resources. The economic impact of recreation expenditures on the local economy caused by effects of plants on recreation is of great interest, because the changes in recreation trips are a response to aquatic plant conditions (Bergstrom et al. 1993, McGinnis and Bell 1998). When plant abundance or densities result in fouled boat propellers, tangled water skis, closed swimming beaches, and degraded water

20020926 052



quality conditions, then the public's recreation use and satisfaction, and resulting expenditures and economic impacts, are affected. This article reports on investigations of economic impacts by one segment of lake users—anglers—at two lakes in South Carolina (Lake Moultrie and Lake Murray) that currently manage nonnative aquatic plants after previous high plant infestations.

Nonnative plant conditions at Lakes Moultrie and Murray provide two different aquatic plant environments. Lake Moultrie currently has few plants, while Lake Murray is experiencing an increase in nonnative vegetation. Historically, Lake Moultrie has supported a variety of nonnative vegetation of floating and submersed species.¹ These plants have affected power generation, domestic and irrigation water supplies, in addition to recreation—boating, swimming, angling—and public access in general (South Carolina Department of Natural Resources 2001). The increase in hydrilla infestation in the early 1990s led to the stocking of triploid grass carp, beginning in 1992. During the creel survey period at Lake Moultrie (March 2000 to February 2001), less than 1 percent of the lake had floating or submersed vegetation (50 out of 60,400 acres). This low level of vegetation is attributed to control by the triploid grass carp.

At Lake Murray, hydrilla, the only abundant nonnative species, peaked around 1996 and was treated with herbicides. Since 1999, hydrilla coverage has been increasing; Murray anglers are fishing in a lake with an increasing

overall plant population, even while control is maintained at priority areas, e.g. developed shoreline, recreation use islands, lake access points, and utility withdrawals. During the creel survey period at Lake Murray (July 2000 to June 2001), nonnative vegetation covered 5 percent of the lake (2,500 out of 50,000 acres) (South Carolina Department of Natural Resources 2001). Also, since the high levels of hydrilla in 1996, residential development around Lake Murray has intensified, increasing aquatic plant visibility to the public.

Approach and Methods

Overall Approach

Economic impacts are evaluated with ongoing surveys, in this case creel surveys, and models that estimate economic impacts to the regional economy. The creel surveys were used to collect expenditure and aquatic plant information—effects of aquatic plants on fishing, preferences for plant levels or plant control, and changes in recreation under different plant conditions.

Economic impacts are based on the expenditures of different angler spending groups; different groups have different spending patterns (on-shore vs. boat angler, day visitor vs. overnight visitor), and the linking of those expenditures to changes in regional demand for goods and services. The impacts of recreation expenditures on economies around Corps of Engineers lakes have been documented since the early 1990s (Jackson et al. 1996, Propst et al. 1992). To evaluate economic impacts, the Corps developed procedures for predicting the economic effects of recreation

expenditures—such as gas, bait, equipment, food, lodging—on local economies (Propst et al. 1998). The procedures evaluate the effects of expenditures for goods and services (such as bait), on the local economy.

Public perception and experience with aquatic plants should be accounted for in development of management plans. As noted above, different user segments, e.g. bank versus boat anglers, may have different preferences for plant amounts or areas to be controlled, or evaluations of management actions, e.g. removal of plants. Of interest to the manager are the public's perceptions of the effect of aquatic plants on recreation, desired level of plants, and, in some cases, the form of plant—e.g. emergent versus submersed—encountered by the public. This information and differences between groups is obtained through direct questions, either face-to-face, as with the creels, or with a mailed survey (Henderson 1996).

Expenditures for Fishing Trips

In the creel surveys, the trip expenditure questions follow the “What did you catch?” “Target species,” “How many people in the party?” and other questions of the creel survey. There was a difference between the number of expenditure categories collected at Lake Moultrie and Lake Murray (Figure 1). This difference means that more types of trip costs were captured by the Moultrie survey than the Murray survey, and more of the total economic impacts were identified. Only trip expenditures were surveyed, not expenditures for durable goods (such as new boats) or fishing licenses, used for numerous trips.

¹ Nonnative vegetation at Lake Moultrie includes alligatorweed, water primrose, Brazilian elodea, hydrilla, slender naiad, water hyacinth, watermilfoil, fanwort, and giant cutgrass.

Moultrie Expenditure Categories

Gas for Car and Boat	Food/Beverages/Ice	Lodging	Equipment Rental	Bait	Other Fishing Supplies	Guide Fees
\$	\$	\$	\$	\$	\$	\$

Murray Expenditure Categories

Gas for Car and Boat	Bait	Food	Lodging	Misc.
\$	\$	\$	\$	\$

Figure 1. Expenditure question from Lake Moultrie and Lake Murray creel surveys

Recreation Trips and Aquatic Plant Conditions

To determine the effect of aquatic plants on angling use, the creel respondents were asked how their fishing would change if aquatic plants changed. All anglers were asked about their current number of annual fishing trips. This information was used to establish a baseline or current level of angling use (Tables 1 and 2). Those anglers that had fished during years of high plant levels² were then asked questions on recreation use under higher plant conditions and perceptions of aquatic plants.

Respondents were asked to think about plant conditions during the highest level of plant infestation. Anglers were asked whether their number of trips would remain the same, increase, or decrease if aquatic plant levels increase. The interviewees were asked to estimate number of fishing trips under two different plant conditions--return to former high levels of plants ("Full Plants"), and half the level of the

highest plant conditions ("Half Plants"). These responses from anglers with experience with high levels of plants were expanded to the entire creel sample.

Economic Impacts

Economic impact models for Lake Moultrie and Lake Murray, South Carolina, were developed by ERDC using the Impact Analysis for PLANning (ImPlanTM) software (Minnesota ImPlan Group 1999). ImPlanTM is an input-output economic model that uses raw materials, labor, and other inputs to evaluate outputs of commodities, goods, and services. Input-Output models track the dollars spent on recreation through the local economy. Besides the direct purchase of goods and services, purchases of the raw material, labor, and other re-

quirements are accounted for in the local economic sectors and used to estimate total sales of goods and services, income, and jobs. Changes in the number of recreation trips—due to different plant conditions—result in changes in expenditures and thus changes in economic impacts.

Previous work (Propst et al.1998) established an economic impact region of 30 miles around the lake, roughly one county distance, as the region of economic impact for lakes operated by the Corps. Those visitors from

Table 1
Lake Moultrie Angling Trips

Length of Stay	Current Trips	Trips at Half Plants	Trips at Full Plants
Day Use	31,640	35,516	35,513
Overnight	2,984	3,962	3,915
Total Trips	34,624	39,478	39,428

Table 2
Lake Murray Angling Trips

Length of Stay	Current Trips	Trips at Half Plants	Trips at Full Plants
Day Use	93,381	95,975	101,940
Overnight	2,927	4,282	4,717
Total Trips	96,308	100,257	106,657

² For Lake Moultrie prior to 1992 and for Lake Murray prior to 1996.

outside the impact region (non-residents) spend some of their monies at home or on the way to the lake, so the impact of their expenditures differs from the resident anglers, all of whose expenditures are in the region. Additionally, some economic impacts occur outside of the region because raw materials and other purchases occur some distance from the lake.

Perceptions of Aquatic Plants

Eliciting perceptions of aquatic plants relies on the respondents' awareness of aquatic plants, memory of higher levels of aquatic plant conditions, and ability to accurately evaluate their response to changes in plants.

- ◆ An important piece of information is the perceptions of the effect of aquatic plants on fishing. Since hydrilla has been eliminated by triploid grass carp at Lake Moultrie, the question used was "How has the removal of aquatic weeds affected your fishing?" Respondents' evaluations were "Hurt," "Help," "No Effect," or "No Opinion." At Lake Murray, the question was "How do aquatic plants affect your fishing success?" The Lake Murray responses were "Helps," "Hurts," "Both Helps and Hurts," "No Effect," and "Don't Know/No Opinion."
- ◆ The perception of recreators (both anglers and non-anglers) is that some level of aquatic plants is desirable (Henderson 1996, Bergstrom et al. 1993), but there may be differences in preferences based on the type of recreation activity (e.g. swimming versus skiing) or type of angling (e.g. shore versus boat, different target species). The Lake Moultrie

creel data set allowed comparison of perceptions by type of angler (shore versus boat), and of canal, inshore, and open water anglers.

- ◆ A question on types of plants encountered (emergent, submersed, both) was included at Lake Murray.

Results

Expenditures

At Lake Murray, average trip expenditures for day users were \$14.60 and for overnight anglers \$61.08. At Lake Moultrie, the day users averaged \$41.94 and overnight trips \$247.57. In all cases, boaters spent more than non-boaters and anglers from outside the economic impact region spent more than residents of the region, i.e. counties within 30 miles of the lakes. The higher average expenditures at Moultrie are attributed to more extensive expenditure data collected, pointed out above, and may also result from differences in recreation patterns at the two lakes including: average overnight trips to Moultrie were 4 nights versus 2 nights at Lake Murray; and Lake Moultrie's regional prominence for striped bass and catfish fishing, and the resulting expenditures related to fishing guide services.

Aquatic Plant Conditions and Recreation Trips

Tables 1 and 2 show trips under current conditions, and trips for "Half Plants" and "Full Plants." For Lake Moultrie (Table 1), estimated trips increase by 14 percent when plants increase to half their highest level, and basically remain the same after the half plant level ("Full Plants" trips are less than 1 percent lower.)

During the creel survey year, there were an estimated 96,000 trips to Lake Murray (Table 2). If plants increase to half historic level, use would be 100,000 visits and 106,000 trips at full plants, the historic high level. This is an 11-percent increase in angling trips if plants return to their historic high level.

Economic Impacts

The ImPlan models developed by ERDC used average expenditures for each recreation expenditure group to evaluate the economic impacts for the Current Conditions, Half Plant, and Full Plant conditions (Tables 3 and 4). This procedure was expedited by using software utilities developed for the Corps, known at the MIREC utilities, meaning Micro-ImPlan Recreation Economic Impact Estimation System (Chang 2000). MIREC groups or aggregates the industries that are affected by recreation expenditures, and whose pattern of input-output mechanics or pathways are similar, e.g. local raw materials versus out-of-region materials. Expenditures collected at Lake Moultrie and Lake Murray fall in the following MIREC groups: Gas and Oil; Sporting Goods; Groceries; Restaurant; Lodging; Other Recreation and Services; and Miscellaneous Expenditures and Souvenirs.

Economic impacts are reported as output, income, and jobs. Output is the total demand for goods and services—direct purchases (i.e., the expenditures reported on the survey), indirect expenditures for raw materials required for the goods and services, and the induced demand from additional income from the producers of the goods and services. Income is reported here as payroll costs—wages and salaries

Table 3
Economic Impacts – Lake Moultrie

Plant Conditions	Output	Income	Jobs
Current	\$2,617,263	\$1,222,841	52
Half Plants	\$3,122,868	\$1,336,386	62
Full Plants	\$3,126,766	\$1,338,637	62

of workers as well as benefits such as health and life insurance, retirement payments, and non-cash compensation. Jobs are reported as annual average jobs—full-time, part-time, and seasonal jobs are reported together as full-time equivalents. For instance, the 62 jobs reported in Table 3 for Moultrie under “Half Plants” are a combination of full-time, seasonal, and part-time jobs.

Which businesses or jobs are impacted by changes in aquatic plants?

Because the I-O model accounts for purchase of labor and raw materials, and aggregates output, income, and jobs within industries, e.g., Hotel and Lodging, Construction, the industries affected and magnitude of impacts can be readily identified. Eating and Drinking, Hotels and Lodging, and related industries (Food Processing) are the most affected industries. Percentage changes shown reflect the change in output and jobs attributed to angling trips, in comparing “Current Conditions” to “Full Plant” conditions (Highest three industry changes are listed) (Table 5).

Table 4
Economic Impacts – Lake Murray

Plant Conditions	Output	Income	Jobs
Current	\$ 981,335	\$393,716	19
Half Plants	\$1,082,740	\$433,058	21
Full Plants	\$1,302,977	\$515,768	25

Perceptions of Aquatic Plants ♦ Effect of Plants on the Fishing Experience

Anglers at both lakes believe that aquatic plants improve fishing conditions. At Lake Moultrie, the creel sample was divided between Inshore, Open Water, and Canal segments (Figure 2), and respondents were asked about the effect of removal of vegetation on fishing. Among fishermen, 76 percent of the inshore anglers reported that plant removal “hurt” fishing, as compared to 64 percent of open-water anglers, and 59 percent of

canal anglers. There was a significant difference between the three groups at the $\alpha < 0.05$ level.

At Lake Murray, the question was “How do aquatic plants affect your fishing success?” Of the anglers, 62 percent responded that plants help, and 2 percent responded “both helps and hurts.” Responses in Figure 3 are shown by type of plant encountered (emergent, submersed, or both), as reported by respondents. The proportion of “Hurts” responses equals the proportion that said “No Effect.”

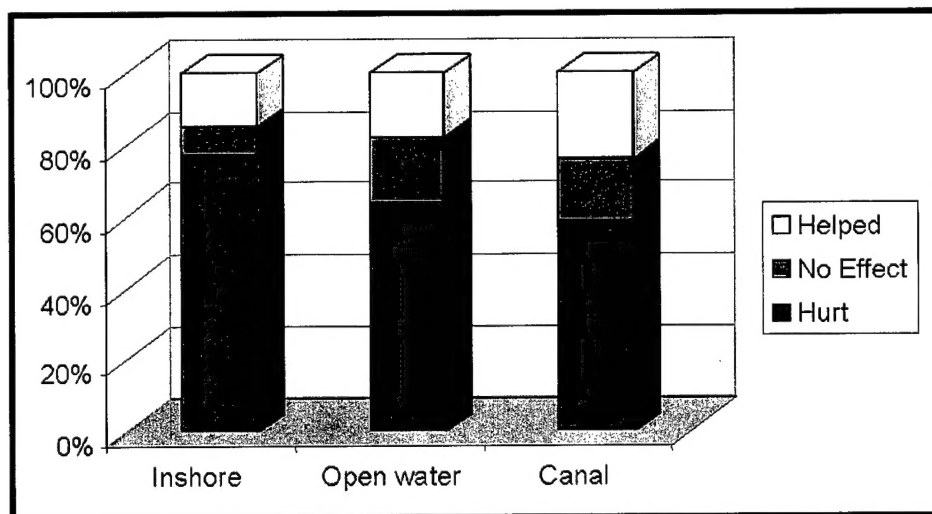


Figure 2. Lake Moultrie “How has removal of weeds affected fishing?”

Table 5
Percentage Increase in Output and Jobs Due to Increased Plants

Lake Moultrie		Lake Murray	
Output/Sales	Jobs	Output/Sales	Jobs
Hotel and Lodging +24%	Hotels and Lodging +25%	Hotel and Lodging +63%	Hotels and Lodging +50%
Eating and Drinking +22%	Eating and Drinking +23%	Transportation +36%	Transportation +33%
Food Processing +22%	Construction +21%	Eating and Drinking +18%	Eating and Drinking +17%

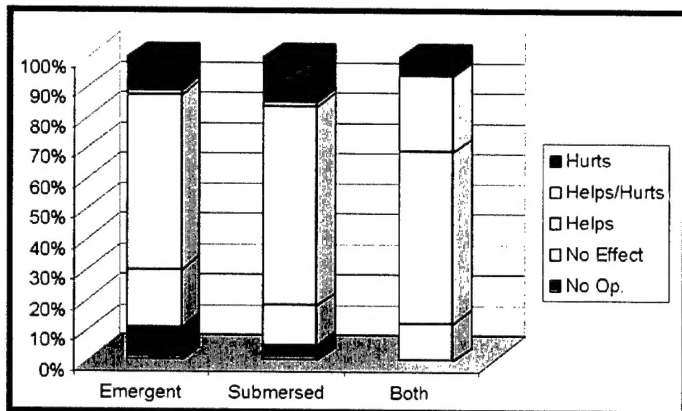


Figure 3. Lake Murray "How do aquatic plants affect your fishing success?"

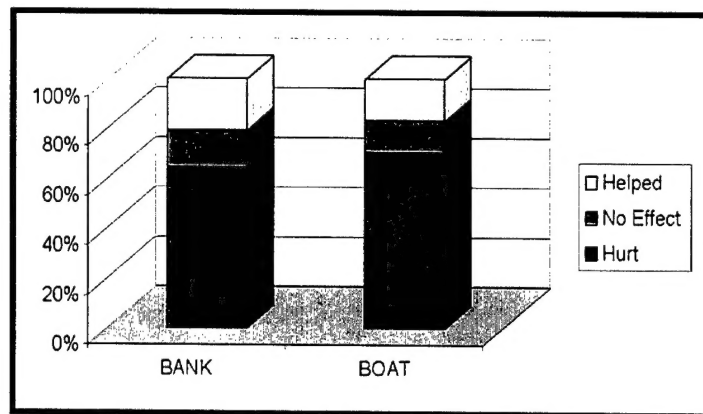


Figure 4. Lake Moultrie "How has the removal of weeds affected fishing?"

♦ Recreation Group Differences – Boat Anglers versus Bank Anglers at Lake Moultrie

The Lake Moultrie data allowed comparison of perceptions of boat and bank anglers (Figure 4). A slightly higher percentage of bank fishers compared to boat fishers (21 percent bank to 15 percent for boat) believe plant removal helped fishing success. Though a higher percentage overall of boat anglers believe plant removal hurt fishing (73 percent boat, 63 percent bank) there was not a statistically significant difference between the bank and boat anglers at the $\alpha < 0.05$ level.

♦ Type of Plants Encountered – Lake Murray

Respondents at Lake Murray were asked "What plants do you encounter most on Lake Murray – submersed, emergent, or both?" The majority of respondents (83 percent) encountered submersed plants, 14 percent encountered emergent, and 3 percent identified both (Figure 5).

Discussion

Anglers at both lakes perceive aquatic plants to be beneficial to fishing. The nonnative plant conditions at the two lakes are different—at Moultrie the non-

natives have been eliminated, at Murray, the nonnatives are on the rise. The implications for aquatic plant management of these results for Lake Moultrie are that economic impacts of recreational fishing will increase as plant abundance increases. The plant abundance that produces the highest level of economic impact is different for the two lakes. Fishing trips at Lake Moultrie increase to the "Half Plants" level and then there is essentially no increase in fishing activity above that level (Table 1). Additional plants would not result in additional trips or increased economic impacts. At Lake Murray, fishing activity increases as the level of plants increase from Current to the Half and Full Plants level (Table 2). The historic high plant

level, or anglers' perceptions of that level, results in higher angler use. If plants exceeded the historic high level, it is likely that fishing would peak at some higher level, not identified by the survey.

Creel surveys proved to be an efficient and effective way to obtain the expenditure, perception, and change in behavior information. The surveys are limited in the extent of questions that can be added to the creel survey, due to time and respondent fatigue constraints. The analysis herein was developed for the region around the lakes; additional information on the proportion of expenditures spent at home and en route to the site would allow broadening the economic impact analysis. However, this would require the respondents to separate

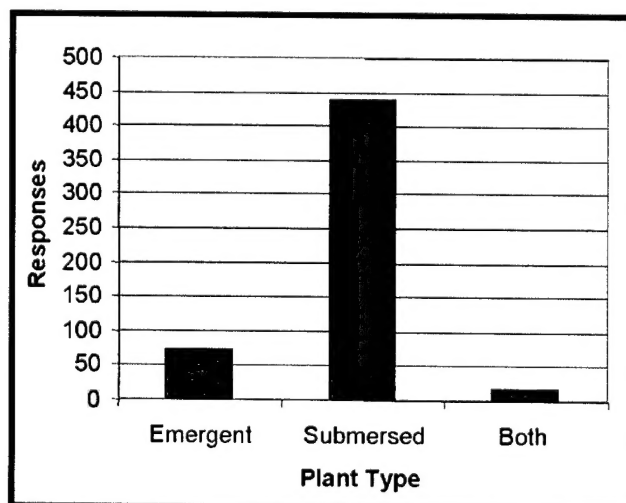


Figure 5. Lake Murray - Type of Plants Encountered

the location of their expenditures, more appropriate for an "at-home" mail-back or telephone survey and not an onsite "in the hot sun" creel interview.

Recommendations

Angler values and perceptions should be viewed as one part of the plant management puzzle. Other lake recreators—water-skiers, pleasure boaters, swimmers—may have differing perceptions on an optimal level of plants, different responses to increases in plants, and different expenditure categories and economic impacts. The economic impacts and perceptions of these other recreation groups, in addition to lake residential homeowners, need to be identified, quantified, and compared to the anglers.

Acknowledgements

The work reported here was performed by the Environmental Laboratory (EL), Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The work was funded by the Aquatic Plant Control Research Program under Work Unit 33307- Economic Value of Aquatic Vegetation to Fisheries. Dr. Phil Kirk and Mr. Jim Henderson are co-principal investigators. This work was assisted by the creel clerks and fisheries managers from the South Carolina Department of Natural Resources. Thanks go to Mr. Scott Lamprecht at Lake Moultrie and Mr. Willard (Gene) Hayes at Lake Murray, who were responsible for all aspects of the creel surveys at the lakes.

References

- Bergstrom, J.C., Cordell, H.K., Teasley, R.J., Souter, R., Messonnier, M.L., Betz, C.J., Smith, M.M., and Barber, L.R. (1993). "Aquatic plant coverage and outdoor recreation at Lake Guntersville, Alabama: A study of user preferences, economic values, and economic impacts," Environmental Resources Assessment Group, Athens, GA.
- Chang, W-H. (2000). "Running tourism impact analysis in ImPlan Pro using MI-REC utilities." U.S. Army Engineer Research and Development Center, Vicksburg, MS and Department of Park and Recreation Resources, Michigan State University, East Lansing, MI.
- Henderson, J.E. (1996). Management of nonnative aquatic vegetation in large impoundments: Balancing preferences and economic values of angling and non-angling groups." *Proceedings of Multidimensional Approaches to Reservoir Fisheries Management*. L.E. Miranda and D.R. DeeVries, ed. American Fisheries Society, Vol 16, 373-381.
- Jackson, R.S., Stynes, D.J., Propst, D.B., and Carlson, B.D. (1996). "A summary of the national and state economic effects of the 1994 recreation program," Technical Report R-96-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- McGinnis, H., and Bell, F.W. (1998). "Economic value of Lake Tarpon, Florida and the impact of aquatic weeds," Kennesaw State University and Florida State University, A.L. Burruss Institute of Public Service, Kennesaw, GA.
- Minnesota ImPlan Group, Inc. (1999). "IMPLAN Professional™ Version 2.0. Social Accounting and Impact Analysis Software," Stillwater, MN.
- Propst, D.B., Stynes, D.J., Chang, W-H., and Jackson, R.S. (1998). "Estimating the local economic impacts of recreation at Corps of Engineers projects—1996," Technical Report R-98-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- Propst, D.B., Stynes, D.J., Lee, J.H., and Jackson, R.S. (1992). "Development of spending profiles for recreation visitors to Corps of Engineers projects," Technical Report R-92-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.
- South Carolina Department of Natural Resources. (2001). "2001 Aquatic plant management plan," Aquatic species nuisance program, Columbia, SC.

About the Authors:



Dr. James P. (Phil) Kirk is a fisheries biologist in the Environmental Laboratory, U.S. Army Engineer Research and Development Center. His interests include reservoir fisheries management, use of triploid grass carp in large systems, and endangered species assessment. Dr. Kirk holds Bachelor's and Master of Science degrees in Wildlife Biology and a Ph.D. in Fisheries from Auburn University. He can be reached at (601) 634-3060 or e-mail James.P.Kirk@erdc.usace.army.mil.

As an environmental planner in the Environmental Laboratory, U.S. Army Engineer Research and Development Center, **Jim Henderson** has been involved in numerous studies to assess environmental programs. These projects include economic valuation of the Corps' Aquatic Plant Control Program, development of the Corps' Regional Recreation Demand Model, documenting environmental features for streambank protection projects, and developing procedures for visual impact assessment for environmental planning and evaluation. He holds a Bachelor's degree in Biology and a Master's degree in Environmental Planning, both from Texas Tech University. He can be reached at (601) 634-3305 or e-mail Jim.E.Henderson@erdc.usace.army.mil.





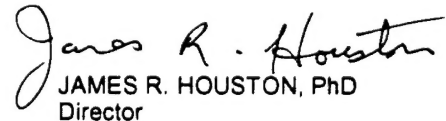
**US Army Corps
of Engineers**

Engineer Research and
Development Center



***Aquatic Plant Control
Research Program***

This bulletin is published in accordance with AR 25-30 as one of the information dissemination functions of the Environmental Laboratory of the Engineer Research and Development Center at the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Aquatic Plant Control Research Program (APCRP) can be rapidly and widely disseminated to Corps District and Division offices and other Federal and State agencies, universities, research institutes, corporations, and individuals. Contributions are solicited, but should be relevant to the management of aquatic plants, providing tools and techniques for the control of problem aquatic plant infestations in the Nation's waterways. These management methods must be effective, economical, and environmentally compatible. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. This bulletin will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: Dr. John W. Barko, U.S. Army Engineer Research and Development Center (CEERD-EV-E), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-3654.


JAMES R. HOUSTON, PhD
Director

OFFICIAL BUSINESS
CEERD-EV-E

DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER
WATERWAYS EXPERIMENT STATION, 3909 HALLS FERRY ROAD
VICKSBURG, MS 39180-6199

BULK RATE
U.S. POSTAGE PAID
Vicksburg, MS
Permit No. 85